Environmental Biotechnology and Bioremediation Training Course

Professional Development Training Course Outline

Category	Biotechnology and Pharmaceutical Development	**Duration**	10 Days
Base Fee	$4,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

The global environmental crisis, marked by widespread pollution from industrial and emerging contaminants, urgently necessitates sustainable biotechnological solutions. Traditional physical and chemical remediation methods are often costly, energy-intensive, and can create secondary pollution. Environmental Biotechnology provides a paradigm shift by leveraging the power of microbial communities, plants, and advanced molecular tools to detoxify and restore contaminated ecosystems. Environmental Biotechnology and Bioremediation Training Course is designed to transition environmental professionals from conventional invasive clean-up practices to modern, eco-friendly, and cost-effective bioremediation strategies, focusing on the future of pollution control and environmental resource recovery.

This training delves into the core principles of bioremediation and biodegradation, emphasizing contemporary challenges such as the remediation of emerging contaminants and heavy metals. Participants will gain expertise in cutting-edge techniques like bioaugmentation, biostimulation, and microbial electrochemistry. We prioritize practical application and regulatory compliance to ensure graduates can immediately implement site-specific remediation design and real-time environmental monitoring, securing a greener and more resilient future for industries and communities alike.

Course Duration

Programme Curriculum

Environmental Biotechnology and Bioremediation Training Course

Introduction

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Course Objectives

1. Master the principles of Bioremediation and Biodegradation for effective pollution control in soil and groundwater.
2. Apply Metagenomics and Molecular Tools for characterizing and monitoring microbial communities in contaminated sites.
3. Design and implement Phytoremediation strategies, including rhizofiltration and phytoextraction, for heavy metal and organic pollutants.
4. Formulate optimal Bioaugmentation and Biostimulation protocols for accelerated in-situ site clean-up.
5. Evaluate the application of Nanobiotechnology and Biosensors for real-time environmental analysis and monitoring.
6. Analyze the role of Metabolic Engineering and Synthetic Biology in enhancing microbial degradation pathways for recalcitrant compounds.
7. Develop strategies for the treatment and Resource Recovery from municipal and industrial wastewater using bioreactors.
8. Understand and utilize Microbial Electrochemistry for simultaneous remediation and energy generation.
9. Conduct comprehensive Risk Assessment and ensure Regulatory Compliance for bioremediation projects.
10. Formulate sustainable solutions for managing Plastic Waste and other Emerging Contaminants
11. Apply Bioprocess Modeling and quantitative tools for effective remediation system design and optimization.
12. Integrate bioremediation techniques with Climate-Smart practices like Carbon Sequestration in soils.
13. Lead the implementation of Microbially Enhanced Oil Recovery (MEOR) and Bioleaching techniques in industrial settings.

Target Audience

1. Environmental Engineers and Consultants
2. Biotechnology and Microbiology Researchers
3. Site Remediation Project Managers

4. Industrial Waste Management Professionals
5. Regulators and Policy Makers
6. Agricultural Extension Officers and Soil Scientists
7. Graduate and Post-Graduate Students in Environmental Sciences/Engineering
8. Professionals from the Oil & Gas, Mining, and Chemical Industries

Course Modules

Module 1: Fundamentals of Environmental Microbiology

- Microbial Ecology and the role of microorganisms in biogeochemical cycles
- Microbial growth kinetics, metabolism, and enzyme function in pollutant degradation.
- Introduction to environmental pollutants and toxicity.
- Factors affecting microbial activity: pH, redox potential, temperature, and nutrient availability.
- Case Study: The use of methanotrophic bacteria to mitigate methane emissions from landfills.

Module 2: Core Principles of Bioremediation

- Defining Bioremediation
- Aerobic and Anaerobic Biodegradation pathways and mechanisms.
- Biostimulation techniques
- Bioaugmentation strategies
- Case Study: Large-scale oil spill bioremediation using bioaugmentation in the Gulf of Mexico

Module 3: Advanced Molecular Tools for Bioremediation

- Metagenomics and high-throughput sequencing for characterizing microbial diversity and function.
- Quantitative PCR (qPCR) and DNA-based methods for monitoring remediation progress.
- Biosensor development using genetically engineered microbes for real-time contaminant detection.
- Techniques for DNA/RNA extraction from complex environmental matrices
- Case Study: Using Pseudomonas fluorescens Strain HK44 as a PAH-degrading biosensor.

Module 4: Remediation of Petroleum Hydrocarbons

- Chemistry of petroleum products and susceptibility to biodegradation.
- Strategies for treating oil-contaminated soil and water
- Role of biosurfactants and bioemulsans in enhancing contaminant bioavailability.
- Selection of indigenous and engineered hydrocarbon-degrading bacteria/fungi.
- Case Study: In-situ and Ex-situ bioremediation of oily sludge at ONGC installations in India.

Module 5: Addressing Emerging and Recalcitrant Contaminants

- Focus on Pharmaceuticals, Endocrine-Disrupting Chemicals, and Per- and Polyfluoroalkyl Substances
- Co-metabolism and reductive dehalogenation mechanisms for chlorinated compounds
- Enzymatic bioremediation.
- Anaerobic processes for the dechlorination of difficult contaminants.
- Case Study: Developing microbial cultures for the degradation of specific pharmaceutical compounds in wastewater.

Module 6: Heavy Metal and Radionuclide Remediation

- Mechanisms of metal-microbe interaction

- Microbial Reduction/Oxidation for transforming toxic metals to less mobile forms.
- Bioleaching and Biomining.
- Genetic engineering of microbes for enhanced metal resistance and detoxification.
- Case Study: Rhizoremediation of Chromium contamination using metal-tolerant bacteria in Southern Brazil.

Module 7: Phytoremediation and Plant-Microbe Synergy

- Mechanisms of Phytoextraction, Phytodegradation, and Rhizofiltration for soil and water cleanup.
- Selection of hyperaccumulator plants and design of vegetative caps.
- The Rhizosphere effect.
- Genetic modification of plants to increase pollutant uptake and tolerance.
- Case Study: Successful phytoextraction of Nickel and Cadmium from mine tailings.

Module 8: Mycoremediation and Fungal Applications

- Role of white-rot fungi and their powerful ligninolytic enzymes.
- Application of fungi for degrading Polycyclic Aromatic Hydrocarbons and pesticides.
- Mycoremediation techniques for both organic and inorganic pollutants
- Designing fungal bioreactors and myco-filters for water and air treatment.
- Case Study: Fungal degradation of specific azo dyes and organic pollutants.

Module 9: Bioremediation of Plastic Waste

- The challenge of Microplastics and plastic-degrading enzymes
- Isolation and characterization of natural plastic-degrading microbial strains.
- Current research in engineering super-degrader microbes using Synthetic Biology.
- The role of bio-based plastics and microbial production of biodegradable polymers.
- Case Study: Recent breakthroughs in enzymatic breakdown of polyethylene terephthalate (PET) plastic.

Module 10: Environmental Bioprocess Modeling and Design

- Introduction to bioreactor kinetics and mass transfer principles.
- Quantitative tools and Process Modeling software for bioreactor design.
- Modeling microbial growth, substrate utilization, and competition.
- Application of models for optimizing parameters like hydraulic retention time and recirculation rates.
- Case Study: Simulation-based design for a multi-component activated sludge system.

Module 11: Sustainable Wastewater Treatment and Resource Recovery

- Advanced biological nutrient removal systems.
- Anaerobic Digestion and biogas production from municipal and industrial sludge.
- Moving Bed Biofilm Reactors and Granular Sludge Technology.
- Microalgae-based systems for wastewater polishing and co-production of biofuels/bioproducts.
- Case Study: Implementation of an Anammox system for cost-effective nitrogen removal in a major municipal plant.

Module 12: Bioelectrochemical Systems (BES) and Innovative Technology

- Fundamentals of Microbial Fuel Cells and Microbial Electrolysis Cells
- Using BES for simultaneous pollutant degradation and electricity/hydrogen generation.
- Electro-bioremediation techniques for enhancing contaminant mobility and degradation.

- Design and operational parameters for scaled-up BES applications.
- Case Study: Utilizing BES for the remediation of contaminated groundwater while producing bioenergy.

Module 13: Soil Health, Climate Change, and Bioremediation

- Integrating bioremediation with Soil Health Management and regenerative agriculture.
- The role of soil microbial communities in Carbon Sequestration.
- Use of Biochar and other amendments to enhance microbial activity and immobilize contaminants.
- Impact of climate change on bioremediation efficiency
- Case Study: Regenerative farming practices and their effect on petroleum-contaminated agricultural land.

Module 14: Regulatory, Risk, and Site Management

- Legal and Regulatory Compliance framework
- Developing a Conceptual Site Model for bioremediation planning.
- Environmental Risk Assessment methodology for biological cleanup technologies.
- Monitoring and verification protocols for proving successful remediation.
- Case Study: Navigating the regulatory approval process for an in-situ bioaugmentation project.

Module 15: Entrepreneurship and Future Trends

- Commercializing bioremediation technologies and developing business proposals.
- The role of Data-Assisted Enzyme Engineering and Machine Learning in optimizing bioremediation.
- Future of Synthetic Biology for creating custom 'super-bugs' for specific pollution problems.
- Bio-manufacturing of valuable products from waste streams
- Case Study: Successful start-ups focusing on commercial-scale microalgae cultivation for CO$_ {2} $ capture and bioproducts.

Training Methodology

This course employs an Active Learning and Contextual Teaching approach to ensure maximum knowledge transfer and practical skill development.

- Interactive Lectures.
- Hands-on Lab Simulations.
- Case Study Analysis.
- Practical Fieldwork.
- Modeling Workshops.
- Project-Based Learning.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call +254769199797

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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